BAKELITE

☆ VARNISH

☆ ENAMEL

☆ LACQUER

☆ CEMENT

HEAT HARDENABLE


BAKELITE
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View of Bakelite Corporation's 125-acre plant at Bound Brook, N. J.

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Third Edition.

BAKELITE

HEAT-HARDENABLE

VARNISH ★ ENAMEL
LACQUER ★ CEMENT

BAKELITE CORPORATION

General Offices: 247 Park Avenue, New York, N. Y.

BRANCH OFFICES: CHICAGO, CLEVELAND, DETROIT, HARTFORD,
LOS ANGELES, SAN FRANCISCO, SEATTLE

PLANTS AT BOUND BROOK AND BLOOMFIELD, N. J.

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BAKELITE CORPORATION OF CANADA, LTD.

163 DUFFERIN STREET, TORONTO, ONTARIO, CANADA

FOREWORD

This booklet deals with four classes of Bakelite materials —varnish, enamel, lacquer and cement. These materials are described with reference to their properties, uses and the methods of applications. They are all of the heat-hardenable type. Baking is required to bring out their best properties.

Bakelite Corporation manufactures and sells these products, but does not manufacture air-drying finishes. It does, however, supply paint and varnish manufacturers with Bakelite synthetic resins from which these finishes are produced.

Bakelite synthetic resins and other Bakelite products, such as molding materials, cast resinoids, laminated products, and resinoid-bonded abrasive wheels, are the subjects of special booklets which may be obtained upon request.

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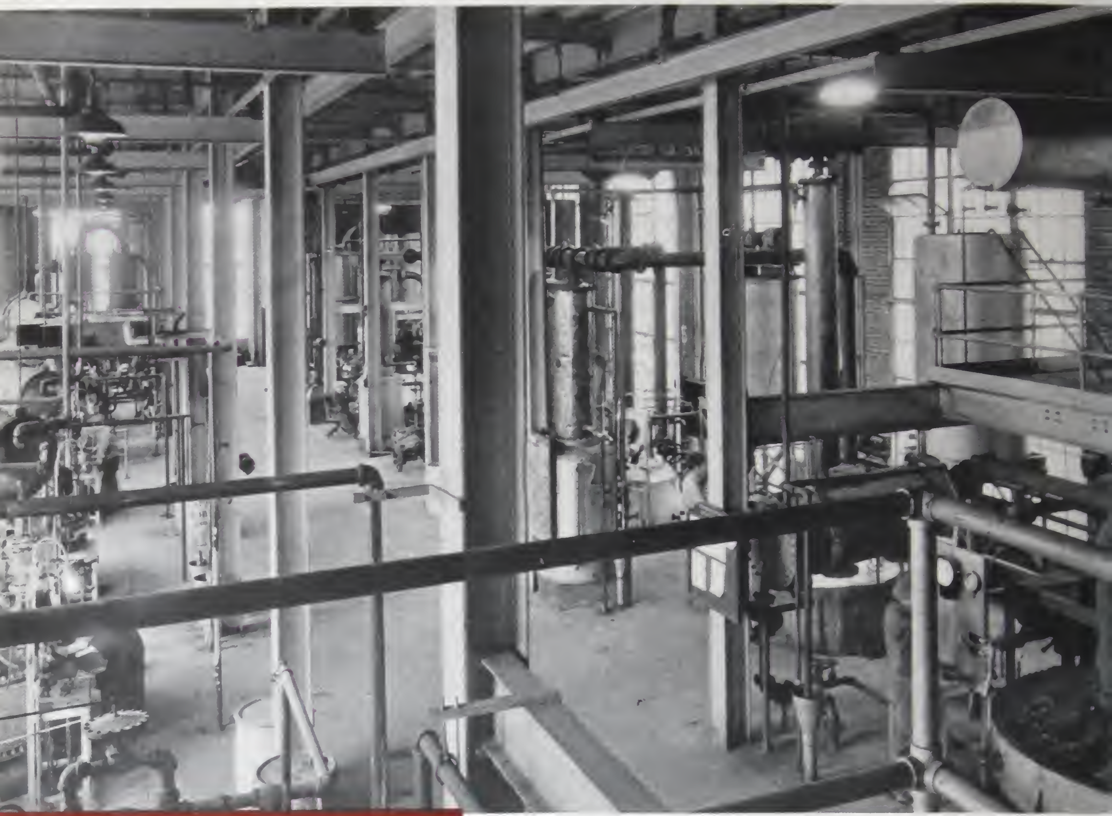


A battery of stills where Bakelite varnishes, enamels and lacquers are made.

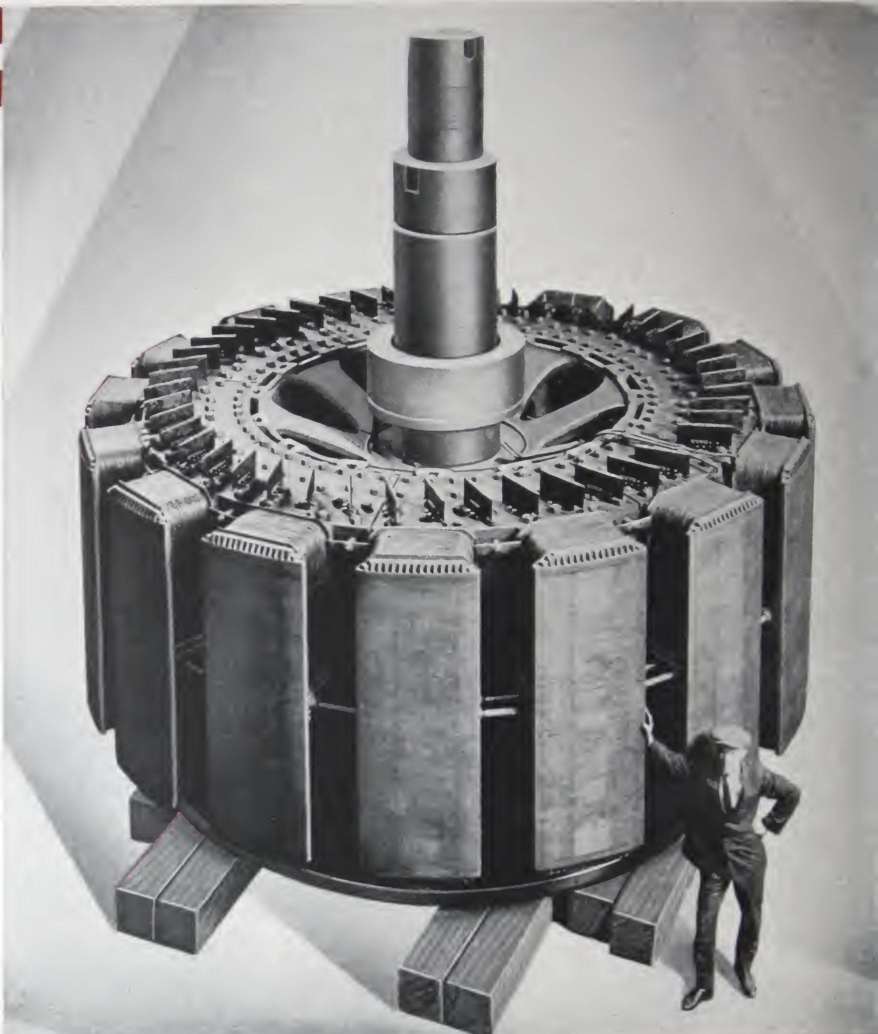
CHAPTER

1 HEAT-HARDENABLE VARNISH

Since the year 1909, when Bakelite resinous products were first announced to the world, the plastics industry has achieved world-wide importance. Where once there was a mere handful of products sold under the trade name "Bakelite," there are now some 2,000 varieties which are the result of years of painstaking research. By variations in formulae, by the introduction of special catalysts or the substitution of the various basic raw materials, new resinous products have resulted with special characteristics and properties which make them particularly suitable to individual requirements.

Among these many Bakelite materials are the varnishes, enamels, lacquers, and cements of the heat-reactive type. In their primary state the Bakelite resinoids, which are employed to produce these products, can be melted and will dissolve in common solvents, such as alcohol and acetone. Application of heat causes them to harden by the process called *polymerization*, after which they are permanently infusible and insoluble. The industrial importance of these products may be attributed to this chemical change. Bakelite heat-hardenable varnish is made by dissolving resinoids in solvents. Natural gum varnishes attain their final protective properties largely by drying and oxidation in the air. On the other hand, resinoid varnishes attain their best properties by being baked at elevated temperatures after they have been applied. Although this baking requires special technical attention, the protective properties of the coatings are far superior in many respects to old type varnishes made with natural gums.

After the varnish is applied, the object is baked to expel the solvent and to convert the resinoid coating to its final resistant and durable state.



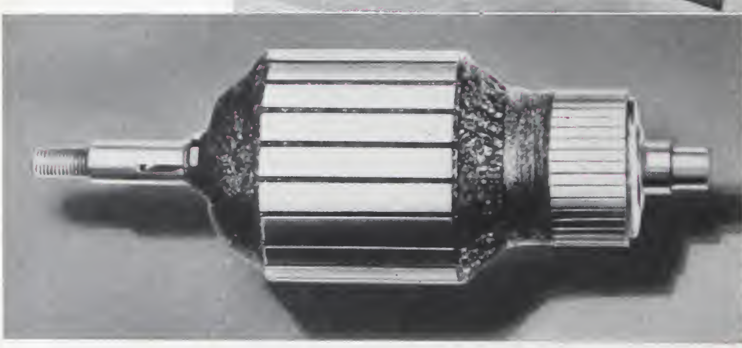


FIG. 1. Armatures of large powerhouse equipment are impregnated with Bakelite varnish

FIG. 2. Bakelite varnish protects small armatures.

PROPERTIES

Bakelite varnish provides a hard, continuous, uniform protective coating for metal. When applied to wood or porous ceramic material it serves for impregnation or surface coating, depending upon the properties desired in the finished work. It is a good electric insulator. From a mechanical standpoint, it provides a tenacious and durable bond. It is non-hygroscopic, and is unaffected by extremes of climate—temperature or humidity. It does not deteriorate, and is unaffected by water, alcohol, acetone, benzine, or other common solvents, oils, greases, organic acids, dilute mineral acids, and most of the soap lubricants. Once converted to the final durable state, it does not melt at any temperature, and will not char at temperatures below 300° F. Its heat resistance may be stated as about 50 per cent higher than that of any other type of organic varnishes. Some special Bakelite varnishes have been developed which will withstand much higher temperatures.

CENTRAL STATION

USES

Bakelite varnish is extensively used as an insulating bond and protective coating for coils, armatures and windings. It is used for such purposes because of its high mechanical bonding strength, dielectric value, and resistance to oil, grease, water, dirt, and gasoline. Armature windings to which it has been applied do not soften and do not "throw out" even when subjected to high rotational speed (Figs. 1 and 2).

Applied to paper or cloth winding strips, it provides a convenient taping material for the insulation of bus bars, and switchboard conduits.

The varnish is also very successfully used as a gasket material for transformer casings. It may be applied directly to the two metal flanges which are pressed into position, without preliminary heating. In steam lines the heat from the steam brings about the transformation. It may also be applied to gaskets made of paper or cloth. Bakelite varnish is used as the impregnation material for gaskets on pipe lines carrying transformer oils. Transformer oils are not injurious to the resinous product, and the heat generated in transformer operation tends to improve its resistant qualities.

In addition to these applications, there are many others in the line of general repair work about the central station.

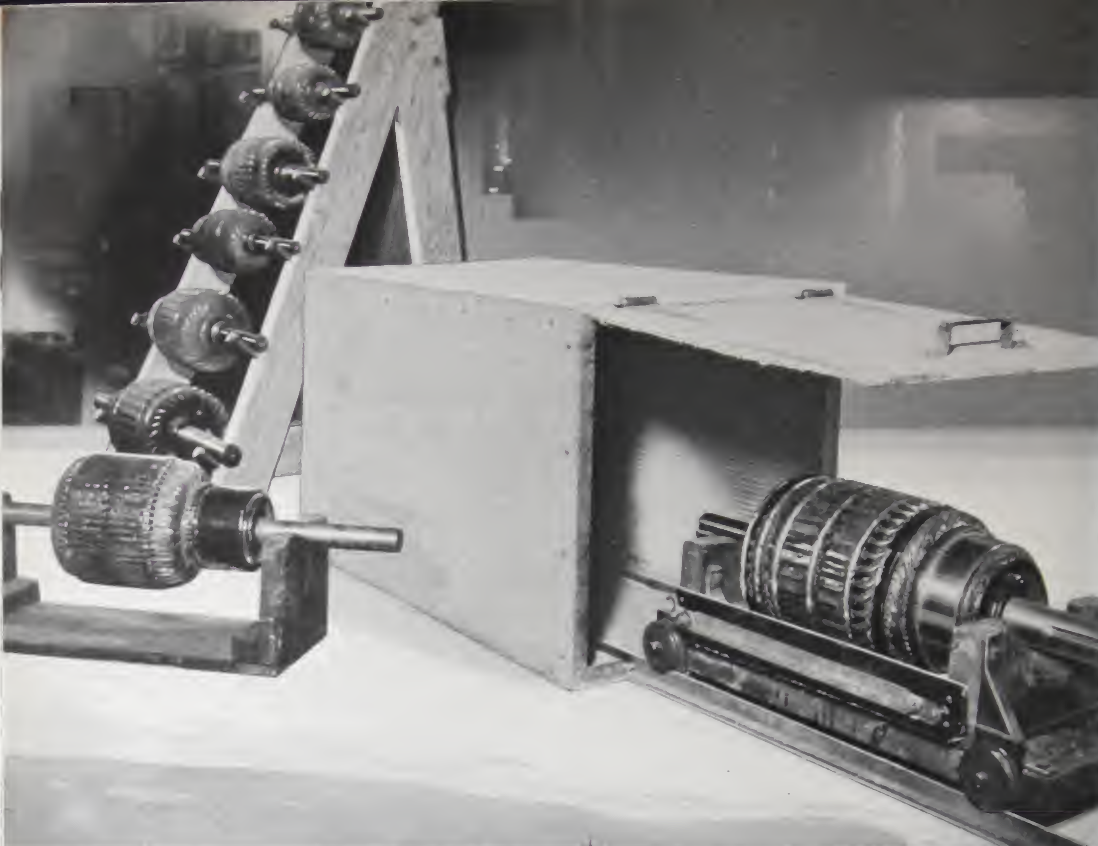


FIG. 3. Cars running on T-rails draw these Bakelite varnish impregnated coils from the baking oven.

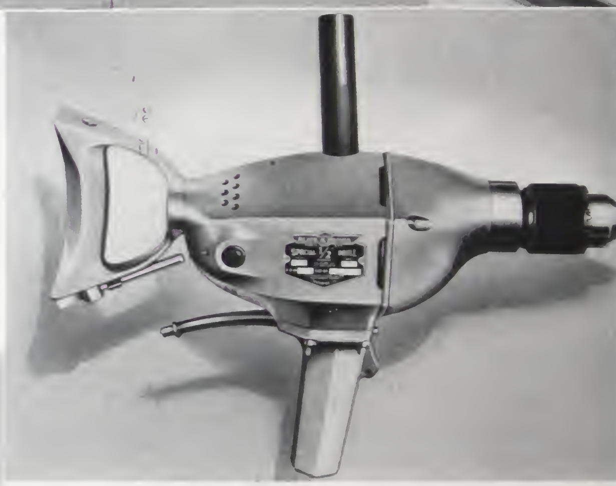


FIG. 4. Armatures of small power tools are impregnated with Bakelite varnish.

FIG. 5. Bakelite varnish insulates the armature of this Gyroscope.

Resinoid varnish in one or more applications is employed on practically all of the large power-house equipment.

MOTOR ARMATURE PROTECTION

In the automotive industry, Bakelite varnish is used in the manufacture and repair of motor and generator armatures. Offering dielectric strength, and permanent resistance to atmospheric attack and to oil, gasoline, and lubricating grease, it serves to increase the durability of armatures. Armatures so treated are superior in temperature resistance, and do not burn out at temporary over-load. The varnish impregnation imparts great mechanical strength to the wound unit. Large quantities of the varnish are consumed by the repair exchanges in making over armature units which have been initially impregnated with other compounds, and have subsequently failed in service.

Resinoid varnish is also used as an armature impregnation for small power tools (Fig. 4) and for heavy electrical industrial equipment. Typical of these applications are motor armatures subjected to severe heat, such as those used on crane motors in the plate glass industry (Fig. 3), armatures subjected to high rotational speed as high as 12,000 R.P.M. (Fig. 5), armatures of high speed generators on automobile trucks, small motor armatures in general electrical service, revolving field coils in elevator operating equipment, field coils on synchronous motors, armatures of ¼ H.P., and 10,000 R.P.M. grinders.

PROTECTIVE COATING

Bakelite varnish has many applications as a protective coating for metal, wood, ceramic materials, and many other substances. A few typical uses are listed as follows:

(a) On chemical processing equipment exposed to corrosive atmosphere.

(b) On wooden fume stacks used in the phosphoric acid industry.

(c) On gas meters to resist attack of hydrogen sulphide.

(d) As protective backing on mirrors used in the headlights of locomotives, etc., to impart resistance to sulphur dioxide.

(e) On interiors of tank cars. (Fig. 9.)

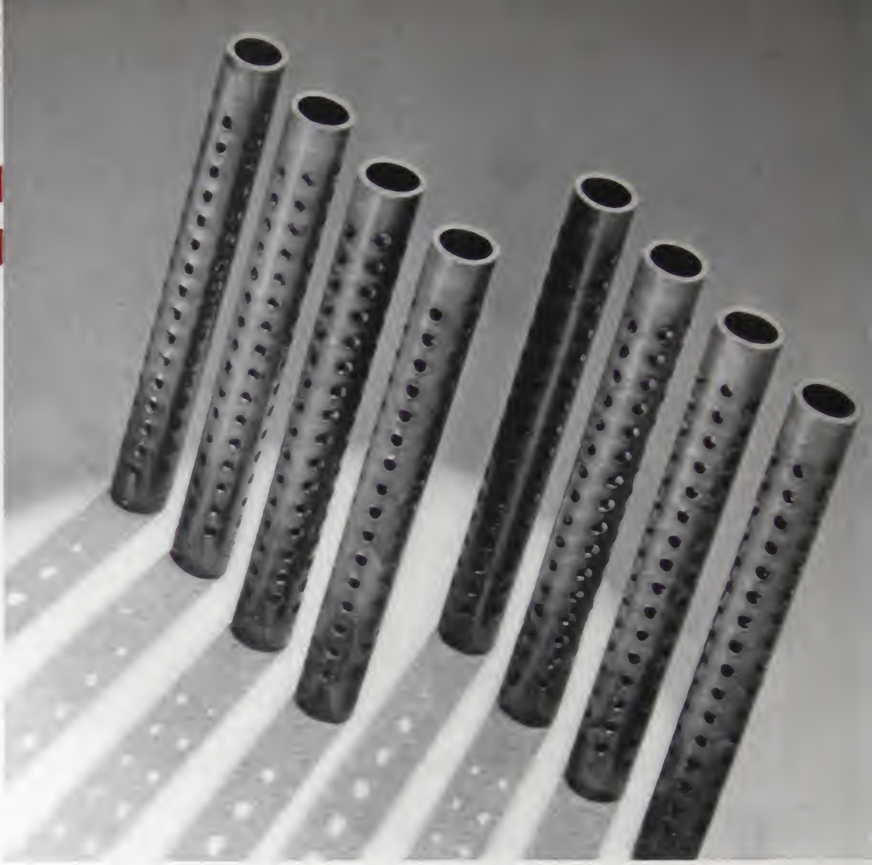


FIG. 6. Paper-wound tubes for textile yarns are protected with Bakelite varnish.

FIG. 7. Bakelite varnish is used for preserving museum fossils.

(f) On industrial equipment to resist weak acids and alkalies; corrosive fumes; alcohol, gasoline and other solvents. (Fig. 10.)

Special baking varnishes have also been developed for protection of parts and equipment employed in textile manufacture. These coatings are especially valuable for aluminum spools exposed to alkaline solutions, iron and steel parts exposed to acid conditions, dryers, and, in general, wherever resistance to chemicals is required. Paper-wound tubes for textile yarns (Fig. 6) when impregnated with Bakelite varnish withstand the action of water, dyes and bleaches, and offer improved resistance to "bleeding."

GENERAL UTILITY

By far the largest field for heat-hardenable varnishes is for impregnating sheets of paper or fabric to produce laminated materials. These impregnated sheets are superimposed to desired thicknesses and subjected to heat and pressure to form a solid, homogeneous stock furnished in sheets, tubes and rods and special forms. This use for varnishes is described in a separate booklet, "Bakelite Laminated," which may be had upon request.

The varnish is extensively employed for numerous industrial applications. To indicate its versatility, a few examples may be cited as follows:

(a) Impregnation of electro-magnet coils on electric chucks used in the grinding industry. The varnish impregnation withstands the action of water, soap lubricants, and other compounds.

(b) To seal joints on gasoline pumps.

(c) To impregnate museum fossil bones (Fig. 7), and to preserve anatomical specimens.

(d) As coating for carburetor cork floats.

(e) To impregnate asbestos commutator rings.

(f) As a protective coating on horn fibre used in construction of cutouts.

(g) To impregnate asbestos separating sheets between primary and secondary coils used in electric welders.

(h) To solidify laminated iron cores of transformers used in radio current rectifiers of the lamp type.

Fig. 8. Bakelite varnish is used to increase capillary surface effect of woven wire screen filters.

Fig. 9. Beer tank car, the interior of which is coated with Bakelite Varnish.

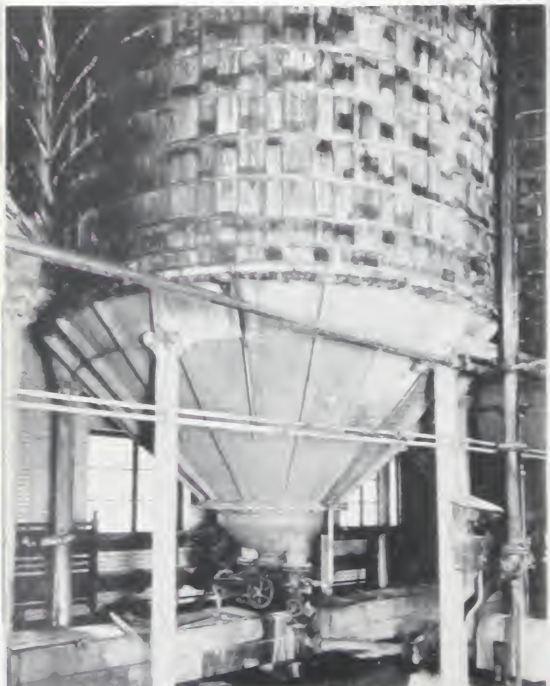


Fig. 10. For the protection of industrial processing equipment against weak acids and alkalies.

(i) To impregnate asbestos composition clutch rings used in automotive manufacture.

(j) As an impregnation material for corks, friction blocks, or pulleys.

(k) As surface coating for plaster of Paris casts.

(l) As a binder for core sand in the foundry field. When mixed with sand and other fillers it may be used to patch large cores.

(m) To impregnate automotive brake linings.

(n) As a bonding agent for wood veneers and plywoods.

(o) To cement cork grips on handles of tennis rackets.

(p) To coat wire trays used in photostat apparatus.

(q) To impregnate paper used in the making of embossing counters.

(r) To increase capillary surface effect of woven wire screen filters (Fig. 8).

(s) To coat metal developing racks to resist the corrosive effect of photographic solutions.

STORAGE

Bakelite varnish is supplied ready for use in the latest types of shipping containers (Fig. 20, p. 25). Depending upon the particular type, it can be stored for a reasonable length of time, varying from one or two months to a full year. Most Bakelite varnish tends to thicken with age, even though it does not lose solvent. This is due to chemical action which in the liquid state proceeds at room temperature.

THINNERS

If the varnish has thickened within limits it can be reduced by the addition of Bakelite thinners.

Special thinners are provided to reduce the varnish to any desired consistency, or to compensate for thickening caused by evaporation of solvents. For best results only Bakelite thinners should be used. In the interest of good service, Bakelite Corporation has found it advisable to manufacture and market such thinners. The particular problems in any application will best determine the type and amount of thinner to be used.

METHODS OF APPLICATION

Bakelite varnish is applied by spraying, brushing, or dipping. Selection of method will depend on several factors

Fig. 11. Bakelite varnish dipping machine.

Fig. 12. Truck for supporting varnished work in oven.

Fig. 13. Oven for drying Bakelite varnished work.

such as size of piece to be treated, scale of operation, design of piece, and thickness of coating or extent of impregnation desired.

DIPPING PROCESS

The dipping process adapts itself satisfactorily to automatic production when many small parts are to be handled. A factory production line can be designed so that the parts will be conveyed through a dip tank (Fig. 11), then through a dryer to dispel solvents, and finally, to the baking oven (Figs. 12 and 13) where higher temperatures are applied. When this continuous process is not feasible, a sufficient quantity of varnish to cover the work in process should be prepared. The dipping may then be done by hand, or by simple mechanical devices to raise and lower objects of large weight into the dipping tank.

The dipping operation is generally most satisfactory when the varnish is of the proper consistency for the particular job in hand. It should further be remembered that heat is not to be applied other than in the baking process. If the varnish be heated during the dipping operation, premature hardening (through polymerization) will result, and thus prevent the end desired, namely, a thorough impregnation.

Surface to which varnish is to be applied should be dry, and free from grease, rust, or scale. Sandblasting, or washing with grease remover, is recommended. Special equipment is not always necessary to carry out the baking operation. When varnish is to be applied to apparatus, which is ordinarily operated under heat, it is frequently possible to secure the baking effect by careful application of heat in the vessel itself. For instance, trays in a dryer used in chemical manufacture may be subjected to elevated temperature in the dryer itself. This step eliminates oven-baking treatment.

The facilities of Bakelite Corporation's Laboratories are available to perform experiments on varnish and its applications to individual requirements.

The knowledge and experience of our Research Laboratories, acquired during more than a quarter of a century, are available to help you in the solution of your problems.

BRUSHING

For pieces having a sizable flat surface, varnish may be applied by brushing. The varnish should be applied rapidly, otherwise it may drag or become tacky. The coats should be drawn out well, with special attention to working the varnish into all seams and crevices. Rough or sharp edges should be smoothed and rounded off. Whenever the varnish coating appears thin at such points, it is advisable that they be given an extra coat. Each coat should be thin and uniform in order to secure good protection and appearance.

Where high insulation properties are desired, or where especially corrosive conditions are to be encountered, it may be advisable to apply as many as three coats, although, ordinarily, two are sufficient.

After applying each successive coat, the work should be baked just sufficiently to dispel the solvents. For small work, the initial baking may require about fifteen minutes at a temperature of 176° F., 80° C. The final coat should be given a longer baking at higher temperatures. Conditions for this final baking will vary somewhat, depending upon the size and nature of the work. In general, the baking operation should result in carrying the polymerization effect in the resinoid material to such extent that the best properties are obtained. It will be remembered that the polymerized resinoid is hard, strong, and generally resistant. Satisfactory results are not likely to be obtained below 230° F., 110° C. Small work requires baking at 248° F., 120° C., for three hours, or 300° F., 149° C., for one hour.

COIL IMPREGNATION

Three methods of coil impregnation are commonly used —dipping, double dipping, and vacuum impregnation. Coil impregnation technic differs somewhat from the methods used to coat non-electrical equipment. In coil impregnation the purpose is to secure an insulating effect by penetration of the varnish. Further, the varnish may be required to add to the mechanical strength of the finished unit, in addition to improving the electrical-insulating and corrosion-resisting properties.

When winding coils for Bakelite varnish impregnation, it

is essential to omit all insulating materials containing oils, paraffin, or other non-absorbent substances. To secure best results, the coil should be wound with untreated tape or paper.

After impregnation, and prior to the baking operation, coils exposed in the air will retain their flexibility for some time, so that wire can be bent and otherwise manipulated without injury to the insulation.

A special type of Bakelite varnish has been developed to impregnate enamelled wire coils and armatures. This varnish will not attack enamelled wire which has been properly baked. It possesses good electrical properties, good bonding strength, heat resistance and solvent resistance. Furthermore, it is especially good for applications where corrosive conditions are severe. Additional information on the properties of this varnish and its methods of application may be had upon request.

COIL IMPREGNATION: DIPPING PROCESS

The dipping process of coil impregnation involves the following steps:

(1) Expel moisture from the coils by baking at 225° F., 107° C., for at least three hours or longer, depending upon the size of the coils.

(2) While the coils are still hot, immerse them in varnish, for fifteen to thirty minutes, or until bubbling ceases, at which time they should be removed. The specific gravity of the varnish solution employed in this operation is determined by the particular type of Bakelite varnish used and the nature of the work.

(3) When removing coils, take care to withdraw slowly to insure a smooth, uniform coat. Drain for one hour, and bake in an oven under uniformly maintained temperature of 165° F., 74° C. Time of baking will depend upon nature of work. For ordinary work, six hours is recommended.

(4) Raise temperature to 250° F., 120° C., and bake from 12 to 24 hours. Time of baking will be governed by the size and construction of coils.

COIL IMPREGNATION: DOUBLE DIPPING PROCESS

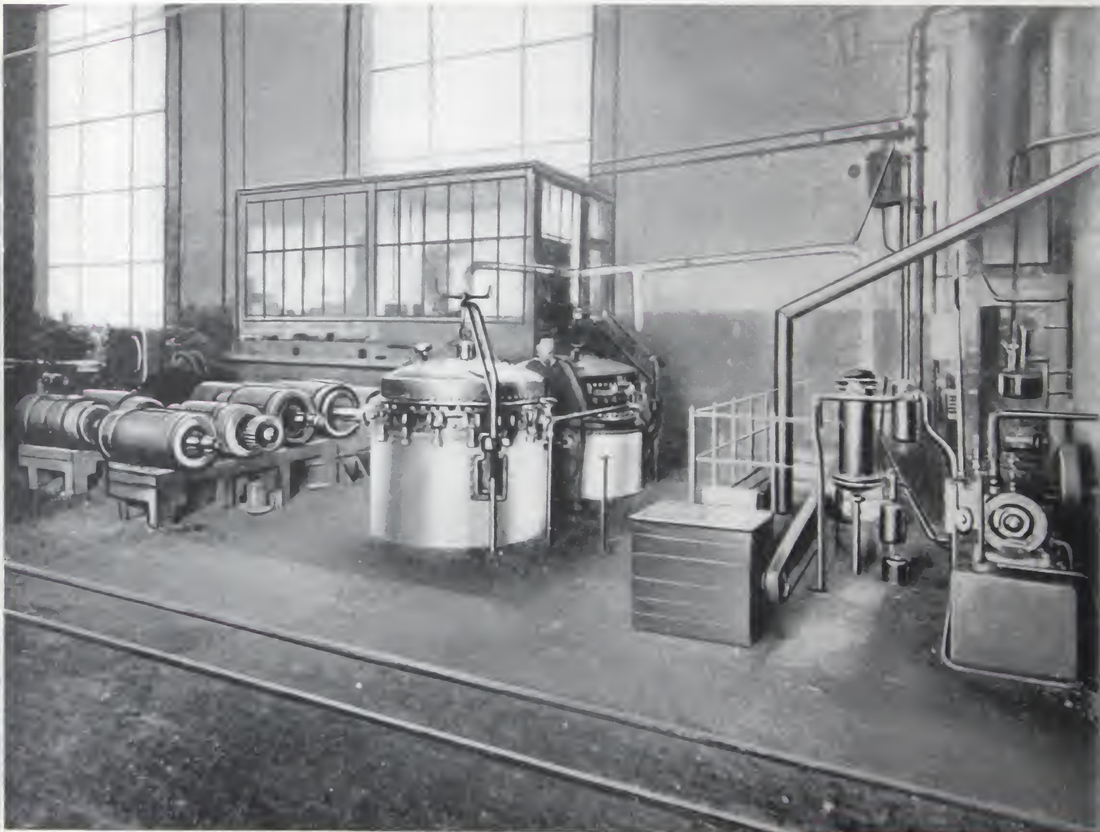
To secure a more highly insulating or generally resistant impregnation, the coil coming from the baking oven (Step 3) may be redipped while still hot, and subjected to the baking period recommended in Steps 3 and 4.

COIL IMPREGNATION: VACUUM PROCESS

For coil impregnation, when maximum penetration is desired, vacuum equipment should be employed (Fig. 14). Coils are first put into the vacuum. Then varnish is forced in under pressure. This alternate use of vacuum and pressure permits the coil to be impregnated to the fullest degree.

Standard equipment may be used except that the impregnating tank should *not* be steam heated. The varnish is already in liquid form, and should not be heated during the process of *impregnation.*

FIG. 14. Vacuum apparatus for impregnating large armatures and coils.



CHAPTER

2 HEAT-HARDENABLE ENAMELS

Much of the descriptive matter in the chapter on Varnish applies to enamels. The typical Bakelite enamel differs from the typical Bakelite varnish in having slightly higher viscosity, and also in the fact that fillers are frequently present. Otherwise, the methods of manufacture, properties, and classifications of use do not differ greatly.

The principal uses of the enamels deal with surface coating rather than with impregnation or cementing.

PROPERTIES

Properties of Bakelite enamel might be classified under three headings—electrical, mechanical, protective. When the resinoid enamel has been baked and fully polymerized, it imparts important electrical insulating properties to the coated surface.

As a protective coating, the resinoid enamel offers resistance to chemicals, heat and humidity. It is non-hygroscopic. It provides effective protection against most chemical reagents, including the common solvents, organic acids, and dilute mineral acids.

In general, enamels may be classified as follows: (1) General protective coating having high resistive properties, but limited flexibility, after baking. (2) General protective coatings, having slightly lower resistive properties, but possessing a marked degree of flexibility.

USES

Bakelite enamel is used in many lines of industry. The following examples are typical:

(a) Drying equipment to protect metal surfaces from the fumes of sulphuric and hydrochloric acid.

(b) Miscellaneous factory equipment which must resist the fumes of dilute hydrochloric acid and acetic acid.

(c) For coating aluminum parts of binoculars (Fig. 15).

(d) As a temporary repair material for the lining of kettles used in chemical plants (Fig. 16).

Fig. 15. Protecting aluminum parts of binoculars.

Fig. 16. For lining kettles in the chemical industry.

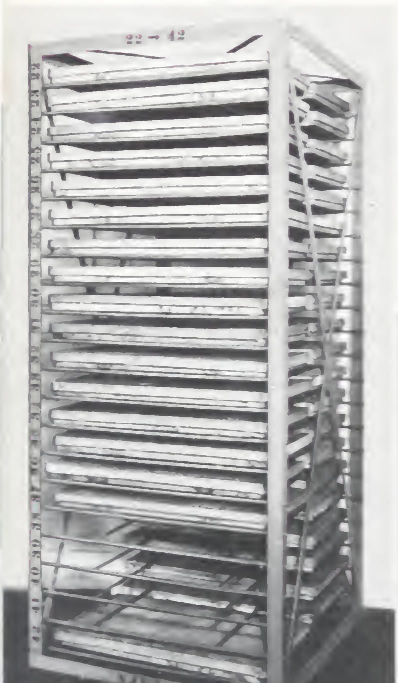


Fig. 17. For protecting bacteria cultivation trays against corrosion.

Fig. 18. For coating the backs of floodlight reflectors.

Fig. 19. For spraying the interior of ironcase meters.

(e) To protect filter press plates from oxalic acid.

(f) As a protective coating for the backs of floodlight reflectors (Fig. 18).

(g) As an impregnation for the reclamation of porous and sweating castings (Fig. 19). It is used for sealing aluminum castings such as those used in the automotive industry.

(h) As a protective coating against corrosion for bacteria cultivation trays (Fig. 17).

METHODS OF APPLICATION

As in the case of varnish, Bakelite enamel may be applied either by brushing, dipping, or spraying, depending upon the nature and volume of the work. When parts can be handled readily, dipping is preferable. The application of the enamel to large flat surfaces requires brushing or spraying.

The methods of applying enamel are similar to those discussed in Chapter I on Varnish (p. 15). The surface to be coated must be dry, and free from grease, rust, or scale. To this end, sandblasting is recommended. Enamel should be thoroughly stirred before using, so that solid matter which may have deposited during shipment and storage will be uniformly distributed. When not in use the enamel should be covered to prevent the entrance of dust and other impurities, and to prevent solvent from evaporating. As conditions warrant, the enamel may be thinned, using Bakelite thinner. One pound of Bakelite enamel, when properly applied on smooth metal, should cover about 100 square feet. This same amount of enamel will provide two coats over approximately 70 square feet of metal surface.

BRUSHING

When applying Bakelite enamel by brushing, the work should be done rapidly, otherwise there will be a tendency for the material to become tacky. The coat should be drawn out well, and worked into all seams and crevices. Sharp edges of metal should be smoothed or rounded off. On sharp edges the enamel coat will tend to be thin, and it is advisable to apply additional coats at such points.

When successive coats of enamel are applied, the work should be baked sufficiently after each coat to drive off all solvents. For initial baking, small work which can be heated rapidly may require only fifteen to twenty minutes, at 160° F., 80° C. After the final coat has been applied, additional baking is at higher temperatures. Conditions will vary with the type of work. Satisfactory results cannot be obtained below 230° F., 110° C. Temperatures of 248° F., 120° C., for three hours, or 300° F., 149° C., for two hours, are generally required.

DIPPING

The directions for dipping are essentially the same as those given in Chapter I on Varnish under the heading "Methods of Application" (p. 17).

SPRAYING

In spraying Bakelite enamels, standard equipment is employed. The dilution is usually controlled by the addition of Bakelite thinner—the spray solution being about 20 per cent thinner, by volume.

The surface to be coated, whether it be external or internal (within a casting), should be dry and free from dirt, grease, and scale. Sandblasting is frequently used, but the parts can be thoroughly washed in kerosene, gasoline, or other suitable grease remover. Enamel should be kept well stirred so that the solid matter will be uniformly distributed throughout the liquid. Sprays should be equipped with air agitators.

IMPREGNATION OF POROUS CASTINGS

Castings, if small, may be dipped in a bath of the enamel. When large castings are to be impregnated, it is customary to fill them with enamel to penetrate all porous spots, after which excess material can be poured out. Large castings which contain only a few porous spots may be treated by application of brush or spray in the sections affected. One coat is ordinarily sufficient. If castings are large and considerably porous, or if subsequent service is to be particularly severe, an air suction line with rubber mouth attachment may be placed against the side of the casting opposite

to that on which enamel is applied. This serves to draw the enamel well into the pores and will give more thorough penetration. When rough aluminum castings in a refrigerating tank are to be treated, the enamel is poured into the tank. Vacuum is then applied on the lines containing the castings. This results in the varnish being drawn effectively into the pores. Preheating the castings to a temperature of 212° F., 100° C., will aid penetration of the enamel. After enamel has been applied, the casting should be air dried for a short time, and then baked at 220° F., 104° C., to 300° F., 149° C., for two or three hours. When more than one coat is applied, the initial coat should be baked only fifteen or twenty minutes, at approximately 135° F., 57° C.

More specific information on porous casting impregnation is given in the special bulletin "Bakelite Sealing Solution for Porous Castings." This bulletin may be had upon request.

FIG. 20. Bakelite varnishes, enamels, lacquers and cements are supplied in the latest types of shipping containers.

CHAPTER

3 HEAT-HARDENABLE LACQUERS

Bakelite lacquers are made by dissolving the primary resinoid in suitable solvents. When the lacquer has been applied to a surface, and the solvents have been allowed to evaporate, a thin film of the resinoid remains. A subsequent heat treatment converts this resinoid film to its final state of durability and insolubility. In this final state, it is highly protective to the surface covered.

PROPERTIES

Phenol resinoid is one of the hardest organic materials known, and the lacquer which it provides is probably more wear resistant than any other type of lacquer. The foregoing statement is based on the results of many experiments. For instance, a number of brass parts coated with various types of commercial lacquers were tumbled with other parts coated with Bakelite lacquer in a barrel partly filled with scrap leather. After a period of several hours, it was found that parts coated with the Bakelite lacquer showed one-fifth the wear of the other samples.

Bakelite lacquers, which are intended primarily as protective coating, retain the color of the initial resinoid—a clear, transparent, light amber.

Bakelite lacquer is practically non-porous and non-absorbent. A brass object coated with ordinary lacquer will still reveal an odor when subjected to friction, whereas all trace of the "brassy" odor will be eliminated when resinoid lacquer is applied.

Most other lacquers, after application, are dried either in the air or in low-temperature ovens. Solvents may be only partially evaporated, thus constituting another cause of residual odors. The higher temperature used in applying Bakelite lacquer serves to expel the solvents. The resinoid itself, when finally converted, is odorless.

Bakelite lacquer is unusually tenacious on metal surfaces. When it has been properly applied and thoroughly baked, the surface will not crack, nor scale, and cannot be peeled by finger nail or knife blade.

Many ordinary lacquers are destroyed at temperatures above 150° F., 66° C.; Bakelite lacquer will withstand a temperature of 350° F., 177° C. Prolonged heating above 200° F., 93° C., will cause the lacquer film to darken slightly, but its other properties will not be seriously impaired at temperatures below 284° F., 140° C. However, at these temperatures its chemical resistance will improve but its flexibility is reduced. Bakelite lacquer does not soften at any temperature. Therefore, there is no danger in shipping products finished with this lacquer to the tropics. Coupled with the heat-resistant characteristics of resinoid lacquer, is its ability to withstand the effect of high humidity, salt water, solvents, and climatic action. Bakelite lacquer film is uninjured by perspiration. This factor is of especial importance to producers of novelty articles, vanity cases, etc.

For the protection of oxidized bronze finishes of the "sulfide" type against so-called "crystal spotting," special Bakelite lacquers are necessary. These lacquers are described in separate bulletins which may be obtained upon request.

"Blushing," a characteristic of many lacquers during periods of humid weather, has in some factories occasioned serious delays in production. Several users have stated that they find Bakelite lacquer superior to other lacquers in its resistance to humidity. Another production advantage is the lessening of fire hazard. Lacquer residue tends to accumulate on spray hoods and vents. The solid content of Bakelite lacquer is practically non-inflammable, whereas the base of many other lacquers ignites easily, and burns with great rapidity.

USES

Bakelite lacquer finds extensive application in the finishing of builders' hardware (Fig. 23). Typical examples are: handles (Fig. 24), hinges, plumbing fixtures, fireplace fittings, knobs, and escutcheon plates. Because of its special properties, the lacquer provides durable coating on ship

Fig. 21. Bakelite lacquers protect belt buckles and vanity cases.

Fig. 22. As a protective coating on transit parts.

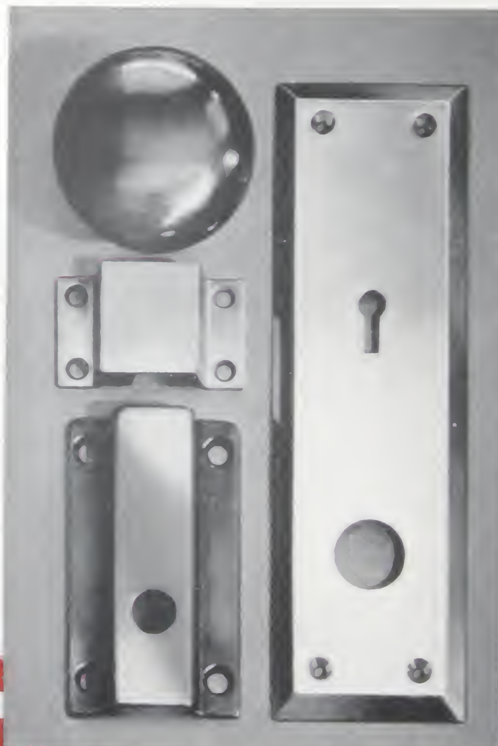


Fig. 23. Bakelite lacquer is used extensively for builders' hardware.

Fig. 24. To protect door grip handles.

hardware, navigation instruments, and, also, for metal parts and devices installed near the seacoast.

For many years Bakelite lacquer has been used as a protective finish on microscopes, transits, and precision instruments in general (Fig. 22), and also for textile spinning spools (Fig. 25).

The value of an inert and permanent surface finish on such apparatus is easily understood when it is realized that it is subjected to constant handling, and to service in all climates of the world.

The use of Bakelite lacquer in the novelty field is extensive and varied. Among the items lacquered are cigar lighters, safety razors, vanity cases, belt buckles, automatic pencils, cigarette cases, clock cases, and ash trays (Figs. 21 and 26).

COVERAGE

A typical Bakelite lacquer, used extensively for machine and basket dipping, has a 40 per cent resinoid content. Its specific gravity is .97, and it weighs approximately 8.08 pounds per gallon. Special Bakelite lacquer thinners are available. While it is possible for lacquer users to make their own dilution, using common solvents, Bakelite Corporation has found that it cannot guarantee the results of this procedure.

The user of lacquer has to consider, in addition to the initial cost per gallon, the actual cost of unit area covered.

Certain lacquer materials, being of high viscosity, are diluted for final application, to a concentration of from 7 per cent to 10 per cent of solid matter. In other words, they require several times their volume in solvents in order to reduce viscosity to a point permitting easy application. Bakelite lacquer, on the contrary, may be mixed in the proportion: two parts lacquer to one part thinner. This produces a solution containing 26 per cent solid matter—about three times that of the best grades of commercial lacquer.

Because of its low viscosity, Bakelite lacquer has a high covering power (approximately 2,000 square feet to the gallon). A 26 per cent Bakelite lacquer solution, ready for application, will deposit the same weight and thickness of

Fig. 25. Bakelite lacquer is used in the textile field to protect spinning spools.

Fig. 26. As a coating for safety razors.

Fig. 27. Pressure gun for spraying Bakelite lacquers.

Fig. 28. Air motor agitator to apply Bakelite lacquers by spraying.

film on a metal surface as will a 7 per cent solution of some other types of lacquers. Therefore, one gallon of Bakelite lacquer is equivalent in surface coverage to three and one-half gallons of certain other types of lacquer.

Inasmuch as the average Bakelite lacquer contains 26 per cent solid matter, compared with 7 per cent in lacquer of another standard type, it will cover about three and one-half times the surface area. The actual cost of Bakelite lacquer per unit of area covered is, therefore, definitely lower than that of most other types of lacquer.

The Bakelite lacquer that is most frequently used for spraying or brushing has a resin content lower than that of the lacquer we have described previously. Specific gravity is .87, and the unit weight is 7.25 pounds per gallon. A solution of one part lacquer to one part thinner can be employed for most purposes. Use of an excessive amount of thinner may create a rainbow effect on the finished surface.

METHODS OF APPLICATION

Bakelite lacquer, in common with all other lacquers, should be applied in a dust-free room. Dust and dirt are the most common causes of blemishes on lacquered goods. Oiling floors, and providing an air filter for the spraying room and for the intake of the spraying equipment, are necessary precautions. Before work is lacquered, all surfaces should be thoroughly cleaned to remove traces of rouge, buffing compounds, dirt, grease, and dust.

In lacquering departments, employees usually wear gloves to prevent spotting the articles which have been lacquered. When Bakelite lacquer is used this precaution is unnecessary. Bakelite lacquer possesses marked resistance to surface abrasion. This is of especial importance to manufacturers of vanity cases, belt buckles, and similar articles which are subjected to frequent handling.

Two methods of applying lacquers are in general use: dipping and spraying.

SPRAYING

Spraying is recommended for large parts, or parts which have undercuts, reversed planes, or grooves, where the lac-

quer might pocket and fail to drain properly. Spraying is preferable also for heavy industrial equipment. Standard air brush equipment is employed (Figs. 27 and 28).

DIPPING

When a great many pieces, of approximately the same size and shape, are to be lacquered, the use of an automatic dipping machine, as described in Chapter 1, page 17, is recommended.

When the parts are large in number, but small in size, or irregular in shape, basket dipping can be used with satisfactory results. For this process the parts are placed in a wire basket which is immersed in the lacquer solution. When withdrawn, the basket and its contents can be allowed to drain slowly, or the excess lacquer can be rapidly extracted in a centrifuge.

Hand dipping is advisable when production is small or when parts of unusual construction are not easily machine dipped.

DRYING

Bakelite lacquer, unlike other types of lacquers, undergoes a complete chemical change during the baking process. The resinoid lacquer film is hard, insoluble, infusible, and generally resistant to chemical action and surface abrasion.

One evidence of this is the fact that the film after drying is no longer soluble in the very thinner that was used to apply it.

The average drying period ranges from fifteen to twenty minutes, at a temperature of 275° F., 135° C. Lacquered objects can be kept in storage, or shipped within a half hour after the lacquer has been applied.

Several leading manufacturers have developed special gas heated ovens designed particularly for Bakelite lacquering service. Upon request, Bakelite Corporation will furnish the names of these manufacturers. Furthermore, our Engineering Department will be pleased to co-operate in the selection of proper oven equipment.

CHAPTER

4 HEAT-HARDENABLE AND SELF-HARDENING CEMENTS

Bakelite cements differ from the varnishes and enamels in that they have a considerably higher viscosity. In addition to the resinoid and solvents, a solid reinforcing body is also incorporated. There are three principal types of Bakelite cement. They are used respectively for general utility bonding, lamp basing, and bristle setting.

Bakelite cements are manufactured in the following forms: (1) Granular powders, (2) highly viscous liquid materials. The first type is made ready for use by the addition of solvents. The second may be used as received, or may be diluted with thinner.

A general utility cement or plastic compound can also be made from a mixture of Bakelite varnish and finely ground asbestos. Another general utility cement can be made by mixing red lead with Bakelite varnish. This latter bond will withstand high pressure, steam, oil, etc. Having a tendency to harden very rapidly, this cement should be made up shortly before application.

GENERAL UTILITY CEMENTS

PROPERTIES

To bring out the best properties of strength and resistance, baking is necessary. When fully baked, the cement is hard, non-hygroscopic, electrically insulating, resistant to all ordinary chemical reagents, such as alcohol, acetone, gasoline, and dilute acids. Bakelite cement provides a strong and durable bond. It can be applied to a wide variety of organic and inorganic materials—wood, paper, fibre, rubber, porcelain, glass, concrete, metal, etc. Once the cement has been fully polymerized it does not melt at any temperature, although it will char at temperatures above 375° F., 190° C.

USES

In the electrical industry, Bakelite cement is used in the manufacture of various devices, including resistors, com-

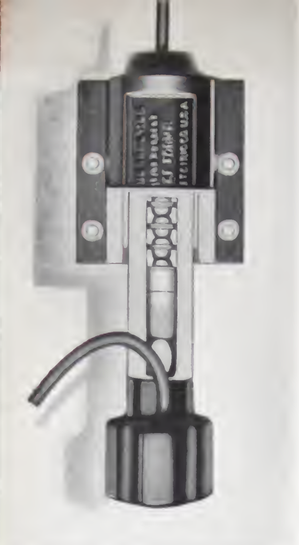


Fig. 29. Parts of lightning arrester bonded with Bakelite cement.

Fig. 30. Cement mixer.

Figs. 31, 32, 33. Bakelite cements are used to set radio tubes, aviation beacon lamps and incandescent lamps in their bases.

mutators, transformers, and lightning arresters (Fig. 29). Roof insulators made of porcelain sections are frequently bonded with the cement, the resinoid content preventing moisture seepage.

Manufacturers of scientific instruments such as recording meters and thermometers use resinoid cement for bonding porcelain, metal, and glass.

METHODS OF APPLICATION

The surfaces to be cemented should be thoroughly cleaned. If grease, rust, or scale is present, sandblasting or other efficient cleaning methods should be employed. Cement should be applied freely and the parts to be joined, pressed firmly together and clamped in place. Excess cement should be removed. Baking, in all cases where the work is of relatively small size, should be at 175° F., 80° C., for a period of one to four hours. The work should then be baked for approximately two hours at 250° F., 120° C. When parts require a large quantity of cement the temperature should be reduced, and the time of baking extended. After preliminary baking (time governed by size of work) at a maximum temperature of 175° F., 80° C., the cement can be hardened in about five hours' final baking at a higher temperature. Excessive temperatures, particularly during the preliminary baking, may cause the cement to become porous, and thus impair its adhesive qualities.

Baking may be done in an ordinary gas or steam heated oven, at atmospheric pressure. A uniform oven temperature should be maintained.

Bakelite cement which has thickened up to a certain point in storage may be thinned or softened by heating at approximately 175° F., 80° C. Only enough cement for immediate use should be softened in this manner. Continued application of heat will cause it to set and lose its plasticity.

LAMP BASING CEMENTS

PROPERTIES

Bakelite resinoid cement provides a strong mechanical bond which is unimpaired by ordinary temperatures encountered in incandescent lamp operation.

USES

Lamp manufacturers early adopted and have continued to use Bakelite cements to set electric light bulbs in their bases. The cement is also employed for basing millions of radio and other electronic tubes (Figs. 31, 32 and 33).

White lamp basing cements are available for basing automobile headlight lamps. They have greater strength and durability than those formerly made from natural gums. These cements may also be used for basing ordinary incandescent lamps.

METHODS O APPLICATIO

Bakelite lamp basing cements are supplied in dry powder form. Each contains all the necessary ingredients except the solvent used to produce a paste.

The paste is made by mixing industrial alcohol in proportion to about 6 per cent by weight, or one ounce of alcohol to one pound of cement. The cement should be thoroughly mixed. Insufficient mixing will impair its adhesive properties. Any efficient mixing machine adapted to handle heavy pastes can be used (Fig. 30). After the cement has been mixed into a paste of the desired consistency, it is usually allowed to stand overnight in a closed container before use.

Lamp bases are filled in any standard base-filling machine and the paste should form a uniform narrow cylindrical ribbon inside the base and near its upper edge. The paste-filled bases are usually allowed to age one day after filling and before use. This permits some of the solvent to evaporate. The filled bases should not be allowed to stand for more than two days, because too great evaporation of solvent results in insufficient fluxing of the cement during the basing operation.

In lamp basing the general practice is to employ circular progressively rotating machines heated by gas flames. The flames are adjusted so that when the finished lamp is removed from the machine the cement has been baked to a final durable bond.

BRISTLE SETTING CEMENT

PROPERTIES

For setting bristles in brushes (Fig. 34) Bakelite cement provides a tenacious bond. It has great durability and excellent resistance to benzine, oils, water and most paint and lacquer thinners which commonly attack other bonding agents.

USES

The range of application of the bristle setting resinoid cement extends from the smallest paint brushes to the large, power-driven, rotary scrubbing brushes.

METHODS OF APPLICATION

Bakelite cement may be varied to any desired consistency by the addition of a special Bakelite thinner. In this way the proper consistency for penetrating various grades of brush bristles can be obtained.

When bristles have been properly arranged in the ferrule, Bakelite cement is poured in at the top. It is then allowed to stand, but care must be taken that the cement does not penetrate below the bottom of the ferrule. Brushes are next stacked with ferrule end down, in racks on a steam plate—time, one hour; temperature 176° F., 80° C. The brushes are then placed in an oven, and baked for two hours or more at 284° F., 140° C. During the initial baking operation, temperature must be regulated with care so that the cement does not flow beyond the edge of the ferrule. The viscosity of the bristle setting cement and the initial baking temperature are important details which must be worked out experimentally in the brushmaker's plant. These factors will vary according to size of bristles, type of ferrules or frames, and absorption characteristics. If the temperature given for the final baking is found too high for certain bristle setting work, it may be lowered and the time of baking increased.

Since the bristle setting must resist alcohol, benzine, turpentine, oil, and water, it is necessary that the resinoid cement be fully polymerized through the operation of baking.

SELF-HARDENING CEMENT

A self-hardening Bakelite cement, which is also heat reactive, has recently been developed. While it will set at room temperature, its action can be hastened by heating.

PROPERTIES

When finally set, this cement is infusible, hard, and water-resistant, and is unaffected by oils, kerosene, and similar solvents.

USES

The primary use of self-hardening cement is for bristle setting, because of its two outstanding advantages. It produces a solvent-resistant bond. And, it has the added advantage, over the regular type Bakelite cement, of enabling brush manufacturers to assemble bristles and handles in one operation. This material, therefore, is especially suitable for manufacturing wooden handle brushes. It is also used to cement knife handles.

METHODS O[F] APPLICATIO[N]

Special Bakelite hardener is required to prepare the cement so that it will harden after being applied. This hardener is packed separately to give the cement a reasonable storage life on the shelf. Ordinarily two parts of hardener by weight to 100 parts of self-hardening cement is recommended. If slower hardening is desired, use 1¾ parts hardener by weight. For more rapid hardening, use 2½ parts of hardener.

The cement can be applied with any sort of convenient spreading device, where two flat surfaces are to be cemented together. It can also be poured in the event that it is used for purposes like the bonding of brush bristles.

When flat surfaces are being cemented together, they should be held together under a pressure of approximately 10 pounds per square inch. It takes about 24 hours at room temperature for the cement to reach its maximum hardness. The hardening process can be considerably hastened by baking. Pieces may be cemented together with a half hour's bake at 180° F., 82° C.

The cement itself is strong, so it is unnecessary to use great caution to obtain a certain maximum thickness of cement

film in order to have the best bond. Nevertheless, it is usually advisable, when cementing two objects together, to keep this film about 1/64 inch thick. This will make a good, strong bond without the possibility of having a starved joint.

When the cement is poured, the vessel used for pouring should be thoroughly cleaned before the cement hardens. Alcohol is an effective solvent of fresh cement for this purpose.

As some filler may settle in the cement over long periods of storage, it is desirable to stir the cement thoroughly before starting to use it. Keeping unopened containers upside down is a good practice. It is better not to plan on storing the cement for more than three months, although in some instances where cans have been kept closed, the cement has retained its original state for much longer periods. The cement should be stored in a cool place. Particular care should be taken to keep it away from radiators and heated pipes.

Some care is advisable in handling Bakelite liquid cements of this character, because it is possible for them to be irritating to the skin. Some individuals are more susceptible than others, but it is safest to arrange operations so that the cement will not come in contact with the skin. Careful washing of exposed parts with alcohol and then soap and water is usually sufficient to prevent irritation.

FIG. 34. Bristles of these brushes are set with Bakelite bristle-setting cement.

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